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Effect of Jute Proportion on the Color Strength Value of Jute/Cotton Union Fabric

R. Prathiba Devi*[1], R.Rathinamoorthy[1] and Dr.J.Jeyakodi Moses[2]

[1]Department of Fashion Technology,

[2]Department of Chemistry, PSG College of Technology, Coimbatore -641 004, Tamil Nadu, India.

Corresponding E Mail: ***prathiba17@gmail.com***

Abstract

The dye ability of the Jute/Cotton union fabric with cotton yarn in the warp and Jute: Cotton yarns in the weft direction were studied with different percentage of Jute/Cotton blend in weft direction. The K/S and colour tri-stimulus values of (reactive dye) the different formulations (Jute/cotton: 30:70, 40:60, 50:50 and 70:30) after and before the softening finish were studied. The experiment focuses on the effect of jute content on the colour strength and fastness properties of finished fabric. The result reveals that, the colour strength value (K/S) was higher in the case of fabric proportion with more jute (70:30 jute/cotton). The finishing process has significant influence on the colour strength value (p<0.05). The fastness properties including light, washing, rubbing and perspiration of dyed fabrics were also satisfactory. To analyse the effect of jute proportion on colour strength and the effect of finishing on colour value, ANOVA was performed.

Key words: Jute/Cotton union fabric, Dyeing, Silicon finish, Colour strength, Fastness properties.

1. INTRODUCTION

Jute fiber is a bast fiber obtained from the bark of jute plant containing three main categories of chemical compounds namely cellulose (58~63%), hemicellulose (20~24%) and lignin (12~15%), and some other small quantities of constituents like fats, pectin, aqueous extract. Jute fiber is composed of small units of cellulose surrounded and cemented together by lignin and hemi-cellulose. [1] Jute is one of the natural fibre, which is underutilized so far, but now a days, a number of value added and diversified products were produced by using jute. The non – traditional application of jute in curtains, upholstery, furnishing textile and apparel textile also increased gradually due to their eco-friendly and bio degradable character.[2] Ramie, flax, hemp and some other vegetable fibers have been used as textile materials, but jute fiber is basically used for traditional purposes such as manufacture of sackings, hessian, carpet backing and the like. [3, 4]

Colouration of jute fabric has become essential for all sorts of fabric starting from decorative value added fabrics to attractive packaging material.[5] While considering the case of apparel enduses, the colouration is mandatory. The fabrics made from jute and cotton blends have a distinct prickling sensation when in contact with the skin. This is due to rigid jute fibers protruding from the surface [6-8]. The properties of jute fiber can be improved through biochemical retting by removing the pectin sheath, the jute fiber is softened [9]. Jute/Cotton blend fabrics have a handle that is rather hard and stiff unless they are treated with finishing components. Unless the quality of the fabric is improved, garments made with Jute/Cotton are not smooth and soft and will not perform well.

Hence this study focuses on the dyeability and colour strength value evaluation of jute/cotton union fabric. The jute/cotton weft yarn with different fiber blend (30/70; 40/60; 50/50 and70/30) composition was woven with cotton warp yarns. The fabric was dyed with hot brand reactive dye. Further to improve the handle value of the fabric, the dyed fabrics were finished with silicon-polyurethane finish. The colour strength, Colour tri-stimulus values were obtained and the effect of dyeing on different blend proportion was analsed before and after finishing process. The wash fastness properties of different jute/cotton blended fabrics were also analysed. The ANOVA were performed to identify the significance of the difference.

2. MATERIALS & METHODS

Materials

Jute/Cotton union fabric with cotton yarn in the warp and Jute/Cotton yarns in the weft direction, with the following fabric specifications are used in this study as in Table 1.

Methods

Conventional Pretreatment of grey fabrics

The union fabrics were subjected to the pre-treatments like desizing, scouring, bleaching and mercerisation [19]. To improve the softness of the fabric, enzymatic treatment was given. The chemicals and auxiliaries mentioned elsewhere in this study were of analytical grade. The reactive dye used was hot brand reactive dye (supplied by Yoshiaki Chemicals Company Pvt. Ltd, India). Further to improve the softness the fabrics were given silicone-polyurethane finish.

Table 1. Fabric specification

30/70 Jute/Cotton union fabric	40/60 Jute/Cotton union fabric	50/50 Jute/Cotton union fabric	70/30 Jute/Cotton union fabric
EPI – 44 PPI - 44 Warp count - 30^s Ne Weft count - 8^s Ne Weight (g/cm^2) - 570	EPI - 48 PPI - 42 Warp count - 30^s Ne Weft count - 4^s Ne Weight (g/cm^2) – 0.623	EPI - 48 PPI - 42 Warp count - 30^s Ne Weft count - 6^s Ne Weight (g/cm^2) – 0.643	EPI - 38 PPI - 38 Warp count - 30^s Ne Weft count - 8^s Ne Weight (g/cm^2) - 710

Dyeing

The enzyme treated jute cotton union fabrics were dyed with hot brand reactive dyes by exhaust or constant temperature method. The dye (3% owf) and sodium chloride (30g/l) was pasted with water at 45 ^{o} C and dissolved by adding water at 80° C and kept for 30 min with material liquor ratio at 1:20. Then sodium carbonate (1% owf) was added for fixation of dyes and run for 1 hour at 60° C. The pH maintained was 5-7. Finally the fabrics were hot washed, soaped, washed and neutralised with acetic acid.

Finishing

An amino functional based polymethylsiloxane silicone softener treatment was carried out by the pad-dry-cure method on the reactive dyed union fabrics, with 10 gpl of amino silicone softener and 10 gpl of polyurethane solution at pH 6.0 (maintained by acetic acid) and temperature of 40°C for 15 minutes with a pressure of 1 kg/cm^2 in order to obtain an optimum pick-up of 0.8% owf. Then the fabrics were dried at 100°C for 3 min and cured at 150°C for 4 min in a drying and curing chamber respectively.

Determination of Reflectance, K/S value and colour strength

The whiteness index (WI), expressed as CIE units was measured for the union fabrics as per AATCC standard test method using international data colour. Colour strength was measured according to the previously reported method by the light reflectance technique, and the relative colour strength was calculated by applying the following Kubelka-Munk equation:

$$\text{Colour strength } (K/S) = \frac{(1 - R^2)}{2R}$$

K, the coefficient of absorption; *S*, the coefficient of scattering; *C*, the concentration of dye; and *R* λmax, the surface reflectance value of the sample at a particular wavelength, where maximum absorption occurs for a particular colourant. The total colour difference (Δ*E*) values were observed by measuring *L**, *a**, *b** values before and after treatment using a computer-aided spectrophotometer along with associated Colour-Lab plus software using the following CIELab equations:

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where

$$L^* = 116\,(Y/Y_o)^{1/3} - 16$$
$$a^* = 500\,[(X/X_o)^{1/3} - (Y/Y_o)^{1/3}]$$
$$b^* = 200\,[(Y/Y_o)^{1/3} - (Z/Z_o)^{1/3}]$$

Chroma (psychometric chroma) values in CIELab colour space were calculated as follows:

$$C_{(ab)}^* = (a^2 + b^2)^{1/2}\ ,\ \Delta C^* = C^*_{1(ab)} - C^*_{2(ab)}$$

where $C^*1(ab)$ and $C^*2(ab)$ are the chroma values for standard sample and produced sample. CIE 1976 metric Hue-Difference (Δ*H*) can be given for CIELab system using the following relationship:

$$\Delta H_{ab} = [(\Delta E_{ab}^*)^2 - (\Delta L^*)^2 - (C_{ab}^*)^2]^{1/2}$$

Colour fastness

The dyed jute/cotton fabrics of different jute proportion were evaluated for their fastness properties according to the Indian standards.

1. Colour fastness to washing – IS-687-79
2. Colour fastness to rubbing – IS- 766-88
3. Colour fastness to light – IS-2454-85
4. Colour fastness to perspiration – IS-971-83

STATISTICAL ANALYSIS

To identify the difference between the parameters like K/S, L*, a*, b*, c*, h* before and after finishing process and also within the different jute/cotton proportion statistically, two factor ANOVA without replications were performed individually. The significance was calculated in the level of 0.05. ($p<0.05$=Significant difference).

RESULTS AND DISCUSSION

The colour strength properties of different combination of Jute/cotton combination were evaluated, which was dyed with hot brand reactive dyes. The Table 2 represents color parameter, CIE L*, a*, b* system, where L* refers to lightness-darkness values from 100 to 0 representing white to black, a* values run from negative (green) to positive (red) and b* values run from negative (blue) to positive (yellow). The CIE lab value of the dyed fabric combination shows that, L value was less in the case of 30/70 (jute/cotton) than 40/60 (jute/cotton). This explains that, the shade was lighter with 40/60 (jute/cotton). But further with other combination, there is a decrease in L value which means lighter shades obtained when the jute percentage increased. The ANOVA results reveal that, there is a significant difference between the colour values of different combinations of jute/cotton blend ($p< 0.05$). The Table shows that the chroma or colour brilliance (C* values) and the h* (colour hue) value of fiber increases with jute proportion except the 40/60 jute/cotton blend. This shows that, higher the jute percentage provides the better chroma value.

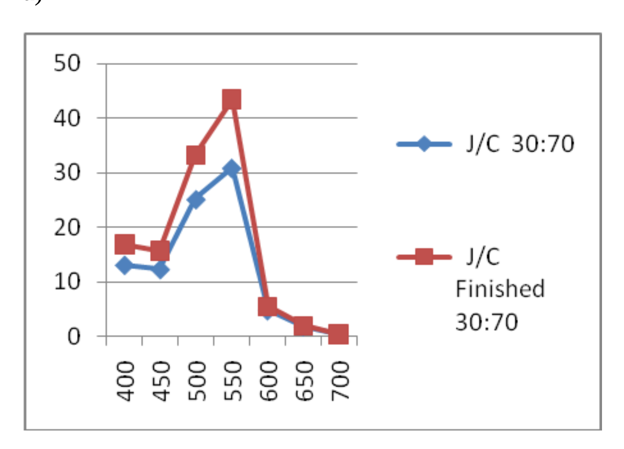
Table 3 represents the CIE lab values after the softening finishing process. The results reveal that, the finishing process has altered the colour strength in a great level, especially in the case of 40/60 (jute/cotton) blend. All the colour co ordinates like, L*, a*, b*, C* and h* were also got affected significantly ($p<0.05$).

COLOUR STRENGTH EVALUATION

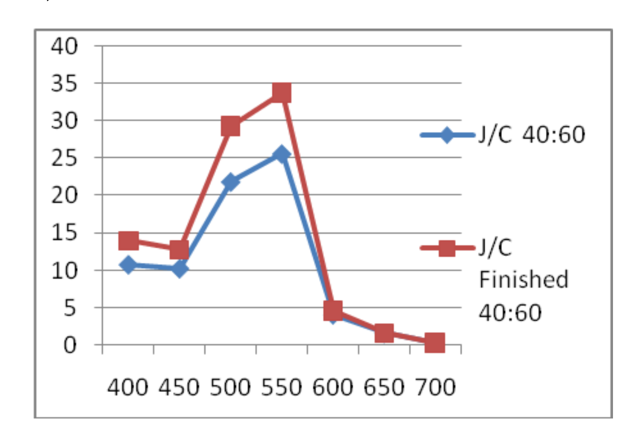
The colour strength value (K/S) of the jute /cotton union fabric at different proportion of jute were analysed. The results were tabulated in Table 4. It can be observed from the table, the K/S value in the visible region has increased significantly after the finishing process. While analysing the K/S value at particular wavelength (λ max - 400) with the different proportion of the jute/cotton, it can be understood that, the amount of of jute content has the significant importance in the colour strength of the fabric. The increase in the jute percentage increases the colour value. This may be because of the multi cellular structure of the jute fiber. The structure with more amorphous regions has more dye intake and forms high colour value. But there is a reduction in colour value observed with 40/60 (jute/cotton) blend.

The finishing process has a significant influence in the colour strength. The over all colour strength value of finshed fabric were observed as increased upto 29 %. But in the case of

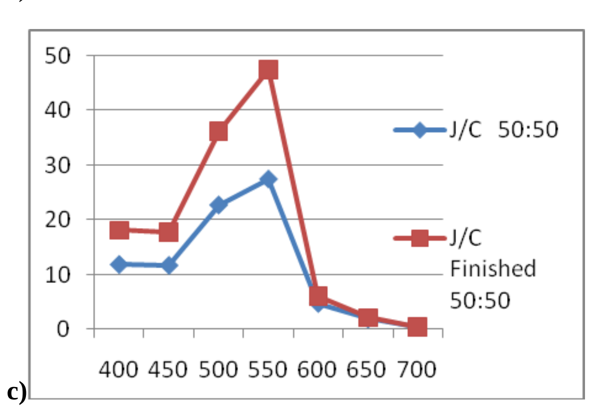
a)



b)



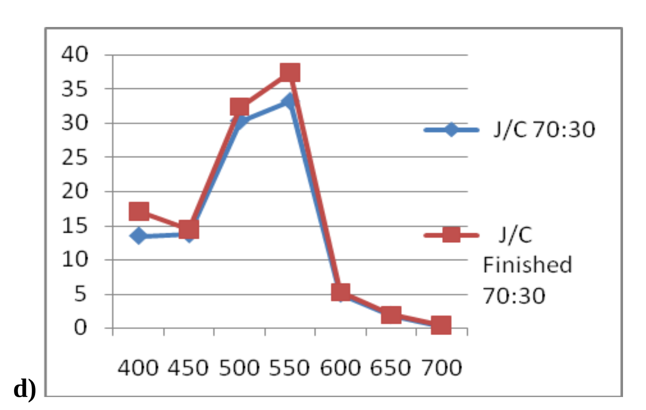
c)



c)

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d)



50/50 (jute/cotton) blend, an increment of 52% was noticed (λ max – 400).

Figure 1 explains the changes in the colour strength of individual jute/cotton blend in different wavelength. The 50:50 jute/cotton blend shows highest difference after the finishing process. However the colour strength value appeared to increase along with the jute content, except 40/60 (jute/cotton) proportion.

Figure 1. (a – d) Colour strength value of jute/cotton union fabric before and after finishing

Table 2. The colour strength and CIE Lab values of Different jute/cotton blends

Parameter	J/C 30:70	J/C 40:60	J/C 50:50	J/C 70:30
L*	21.962	25.734	24.488	23.193
a*	32.981	32.084	30.552	31.721
b*	5.020	3.054	3.581	4.442
C*	32.226	30.761	33.361	32.031
h*	5.435	6.682	6.691	7.768
ΔE	34.842	35.832	33.905	34.333
ΔH	-5.123	-5.035	-5.011	-4.932
ΔC	29.925	29.990	28.523	29.792

Table 3. The colour strength and CIE Lab values of different jute/cotton blends after finishing

Parameter	J/C Finished 30:70	J/C Finished 40:60	J/C Finished 50:50	J/C Finished 70:30
L*	23.950	23.924	21.015	22.584
a*	31.944	33.325	32.121	32.406
b*	3.749	4.595	5.434	4.853
C*	33.64	32.577	32.163	32.767
h*	7.848	9.589	8.651	8.514
ΔE	34.945	36.099	33.814	34.691
ΔH	-4.934	-5.072	-4.741	-4.910
ΔC	31.122	31.402	30.339	30.529

Table 4. Colour strength value of jute/cotton union fabric, before and after finishing at different wavelength.

λ max	400	450	500	550	600	650	700
J/C 30:70	13.059	12.271	25.119	30.875	4.699	1.765	0.303
J/C 40:60	10.797	10.253	21.884	25.633	4.086	1.577	0.275
J/C 50:50	11.82	11.659	22.741	27.483	4.68	1.805	0.296
J/C 70:30	13.51	13.753	30.376	33.277	5.011	1.863	0.306
J/C Finished 30:70	16.897	15.704	33.254	43.529	5.391	1.847	0.3
J/C Finished 40:60	13.973	12.781	29.366	33.826	4.612	1.626	0.27
J/C Finished 50:50	18.068	17.684	36.209	47.502	5.941	2.029	0.324
J/C Finished 70:30	17.045	14.363	32.363	37.438	5.197	1.832	0.328

Table 5. Colour fastness of dyed jute cotton union fabrics

S.No.	Fabric specification	Wash fastness	Rub fastness		Perspiration fastness	Fastness to light
			Dry	Wet		
1	J/C fabric 30:70	4/5	4	3	4	IV/ V
2	J/C fabric 40:60	4/5	4-5	3	4-5	IV
3	J/C fabric 50:50	4/5	4	2-3	4	IV
4	J/C fabric 70:30	4/5	4	3	4-5	IV

COLOUR FASTNESS PROPERTIES

The fastness properties against different sources were obtained for all the jute/cotton union fabrics. Irrespective of the blend proportion, the fastness properties of the fabric observed was good (4-5) for all the tests. The rubbing fastness against wet surface alone noted as 2-3. This shows that, the jute/cotton union fabric has good fastness properties. The results were tabulated in Table 5.

STATISTICAL RESULTS FOR K/S

In both the ANOVA Table 6 and 7 represents that, the p value is less than 00.5. Which means that, the colour difference between the jute/cotton proportion and also before and after varies significant amount statistically. The P-values are used as a tool to check the significance of each coefficient, which also indicates the interaction strength between each independent variable. The smaller the P value the bigger the significant of the corresponding coefficient.

Table 6. ANOVA between different jute/cotton proportions

Source of Variation	SS	df	MS	F	P-value
J/C Bends	44.46472	3	14.82157	5.845267	**0.005701**
Wavelength	3064.023	6	510.6705	201.396	**1.69E-15**
Error	45.64177	18	2.535654		
Total	3154.13	27			

Table 7. ANOVA between different jute/cotton proportions before and after finished (λ max – 400).

Source of Variation	SS	df	MS	F	P-value
Between Groups (before and after finishing)	35.2674	1	35.2674	15.3021	**0.007876**
Within Groups	13.82846	6	2.304743		
Total	49.09586	7			

CONCLUSIONS

The dyeability of the jute/cotton union fabric with different proportion of jute was evaluated for their colour strength and wash fastness properties. The study reveals that, the increment in jute blend proportion lead to increase in the colour strength value except 40/60 jute cotton proportion. The chroma value and brightness values also significantly changed according to the jute proportion. Further in this study, it is noted that, the effect of finishing process has significant influence on colour values. The wash fastness properties of different jute/cotton proportions were also appeared to be same for all the proportions. This study insights the dyeing ability of different proportion of jute/cotton union fabric with reactive dye.

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